

Innovative biotechnology solutions for black stain removal and preventive conservation of historical and culturally important mural paintings



CATÓLICA
ESCOLA DAS ARTES

PORTO

MARCO, A.^(1,2), VIEIRA, E.^(1,2), PINTADO, M.⁽³⁾, MOREIRA, P. R.^(2,3)

(1) School of Arts, Portuguese Catholic University, Oporto, Portugal

(2) CITAR – Research Centre for Science and Technology on Arts, Portuguese Catholic University, Oporto, Portugal

(3) CBQF – Centre for Biotechnology and Fine Chemistry, Portuguese Catholic University, Oporto, Portugal

Introduction

Several Portuguese sets of mural paintings from the XV-XVI centuries allocated in churches, subject to environmental fluctuations where no measures of preventive conservation took place, disclose a chromatic alteration in the form of dark stains.

The cleaning or removal of the pigmentation, without affecting the pictorial layer, hasn't been successful or much tested so far. In order to characterise its composition and achieve pigment removal, innovative methodologies will be tested both *in vitro* and on prototypes of granite and mural painting executed with similar materials to those used in the north of Portugal at the time.

Objectives

This research project aims to determine the characteristics of the chromatic alterations present in mural paintings, focusing in defining the responsible chemical compounds that will allow the testing of innovative solutions for their elimination as well as preventive conservation methodologies applied to non-controlled environmental settings. Although there is an elevated number of churches with such pathologies in the north of Portugal, a reduced number of similar case studies must be considered representative as to draw conclusions and treatments that are valid for other works of art in analogous material and technical characteristics. The study of these churches will also enable the making of granite and mural painting prototypes, executed to simulate the materials and techniques present, as well as the pigmentation detected.

Materials and Methods

- ❑ Sets of mural painting from the XV-XVI centuries in the North of Portugal (fig. 1);
- ❑ Isolation of microorganisms present on mural paintings' surface (fig. 2);
- ❑ Selection of fungal isolates for their pigmentation ability (fig. 3);
- ❑ Analytical methodologies: with optical microscopy (OM), FTIR, SEM, molecular biology (fig. 4), and measurement of total colour difference with CIE L*a*b*;
- ❑ Biocide assays (fig. 5); pigment discolouration assays (fig. 6)



Fig. 1. Sets of mural painting from the XV-XVI centuries with several campaigns.

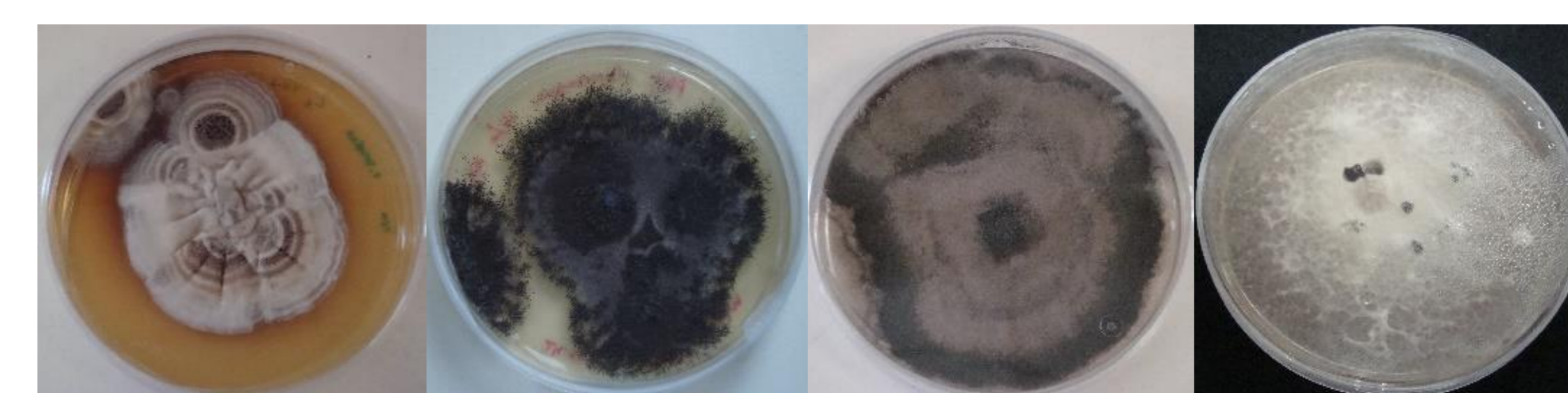


Fig. 3. Some filamentous fungal isolates displaying: colourless hyphae, production of black exudates and deep extracellular pigmentation.

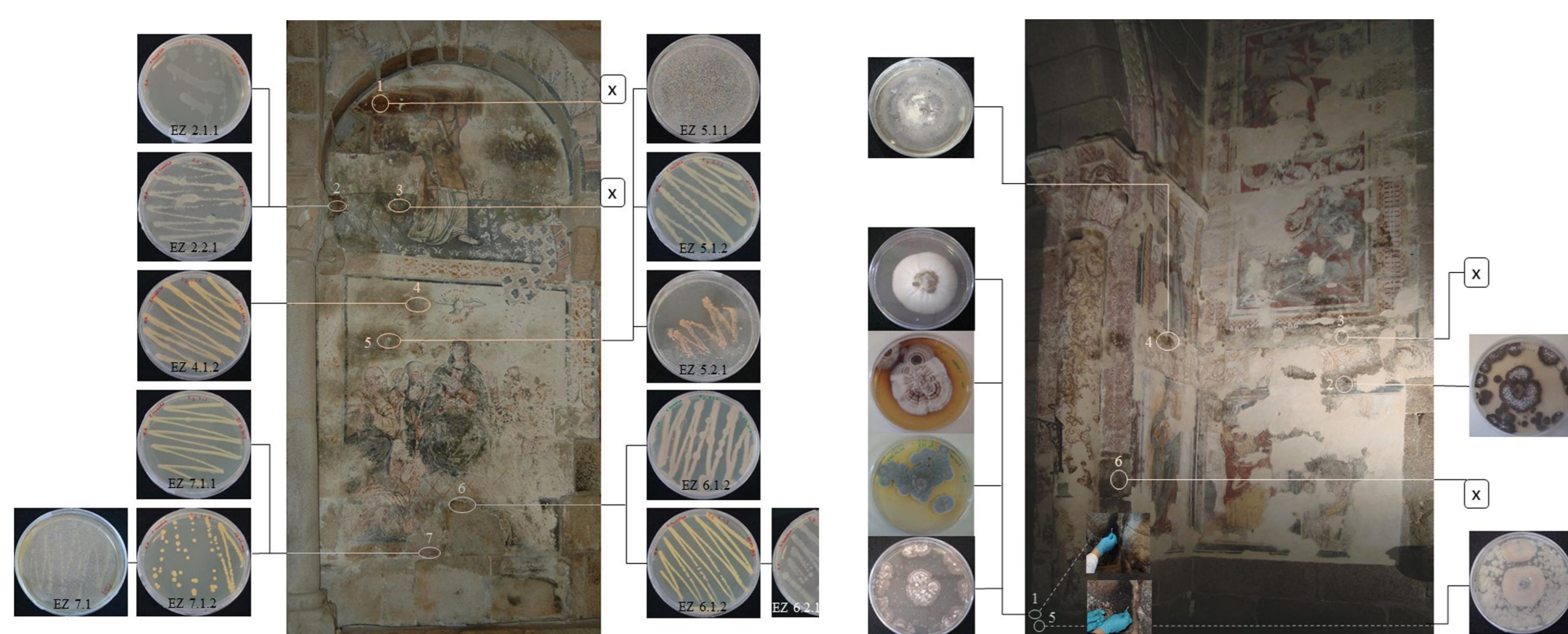


Fig. 2. Location of samples where bacteria, yeast and fungi were isolated.

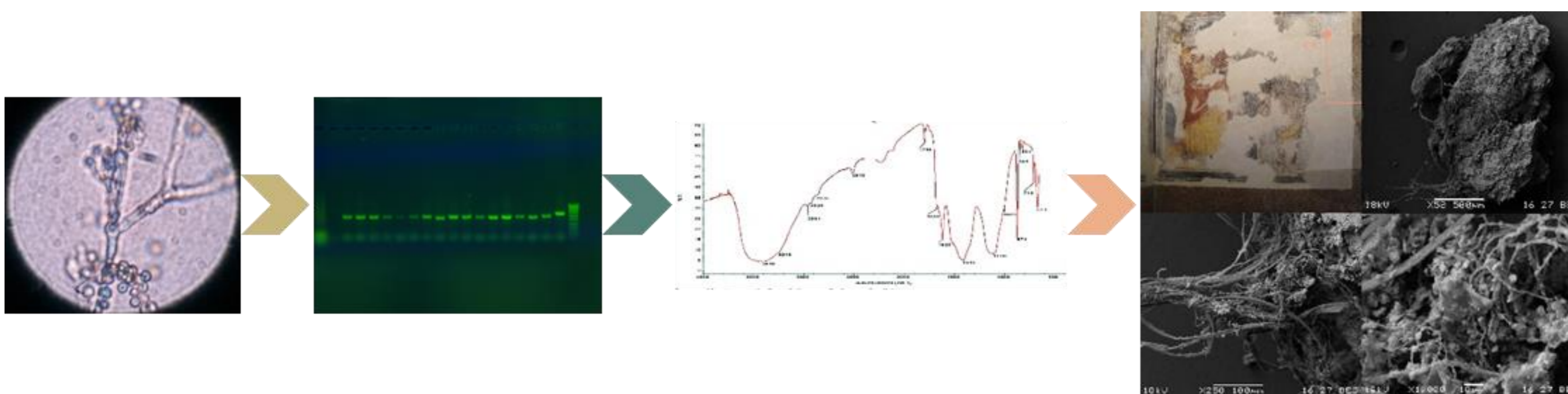


Fig. 4. OM of a fungi isolate; DNA sequencing (molecular biology); FTIR of a mural painting pigment; SEM of a solid mural painting micro-sample

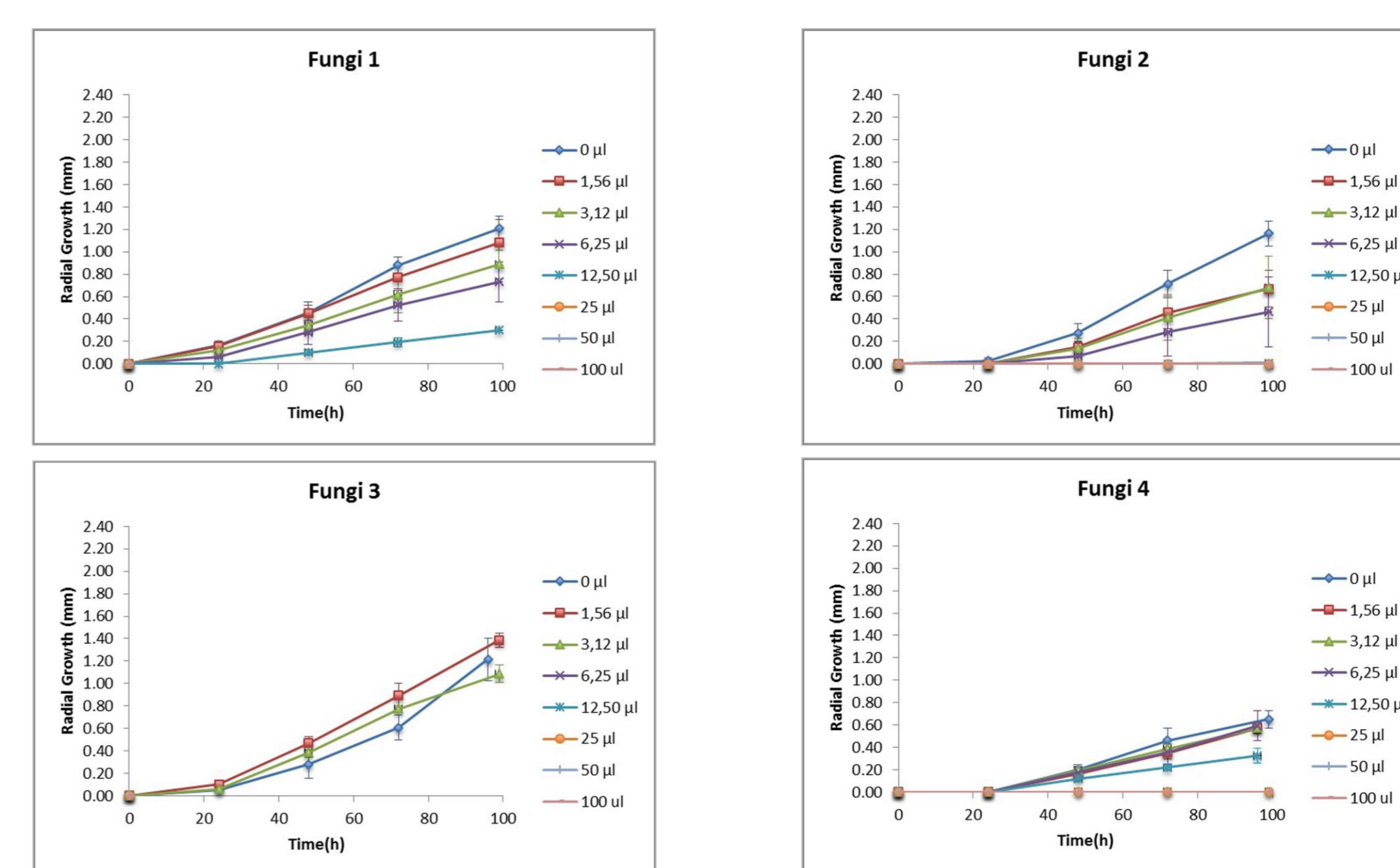


Fig. 5. Biocide assays of for fungi isolates with pigmentation ability.

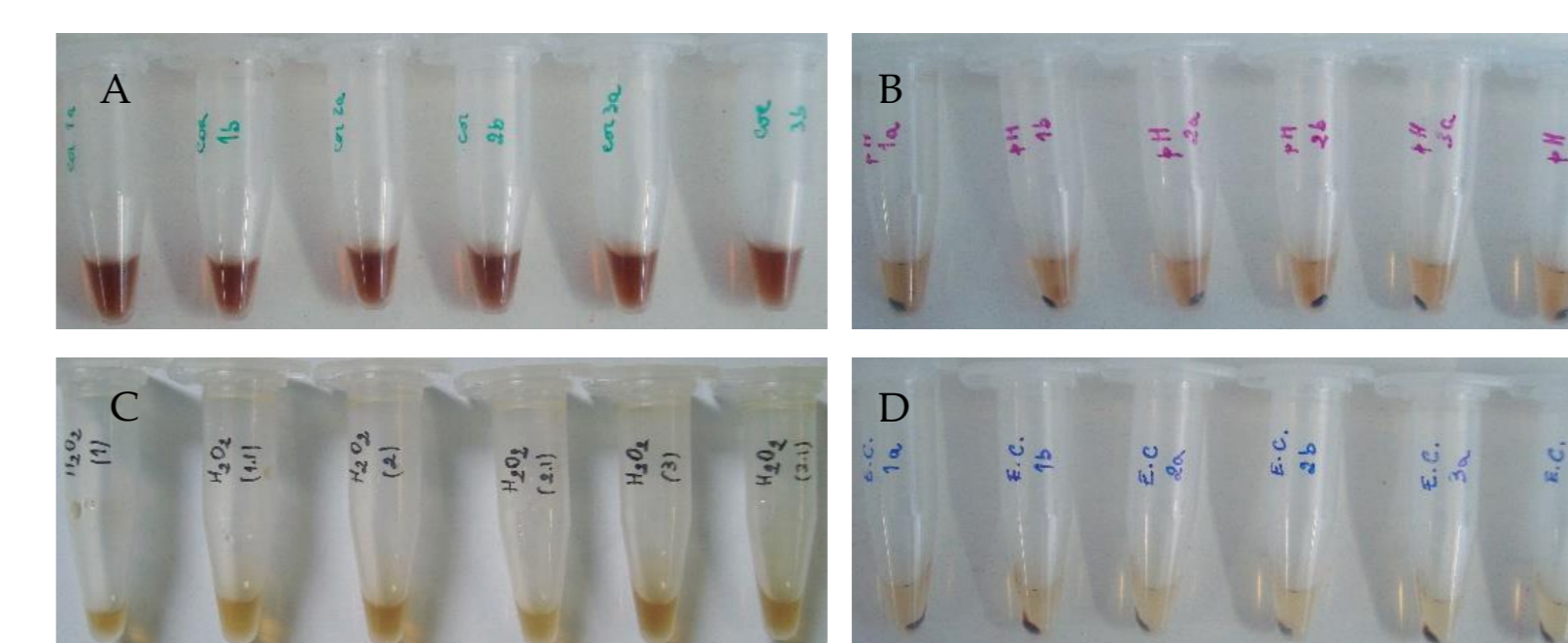


Fig. 6. Discolouration assays: (A) Colour control; (B) pH control; (C) Hydrogen peroxide; (D) full assay with a fungal versatile peroxidase *Bjerkandera adusta* (JenaBios).

Further Work

- Characterization of melanin/pigments and pigments' isolation from hyphae and spores
- *In vitro* assays of biocides' activity on frescos prototypes with the same characteristics as the case studies
- Enzymatic discolouration tests of dark pigmented stains on frescos prototypes and afterwards *in situ*

Acknowledgements

Further work will be carried out as part of the author A. Marco PhD Degree with a grant by FCT (SFRH/BD/125596/2016) and supported by "Fundação para a Ciência e Tecnologia" and "Programa Operacional Ciência e Inovação 2010" (POCI 2010), co-funded by the Portuguese Government and European Union by FEDER Program. Author P. R. Moreira was sponsored by a post-doctoral fellowship granted by FCT (SFRH/BPD/74624/2010, Portugal).